REMARKS/ARGUMENTS

Favorable reconsideration of this application as presently amended and in light of the following discussion is respectfully requested.

Claims 25-39 are pending in this application, Claims 1-24 having been canceled without prejudice or disclaimer; and Claims 25-39 having been added. Support for added Claims 25-39 can be found, for example, in the original claims, drawings, and specification as originally filed.[1] No new matter has been added.

In the Office Action of October 7, 2009, Claims 1 and 21-24 were rejected under 35 U.S.C. § 103(a) as unpatentable over Sportouch et al. (Thermoelectric Properties of Half-Heusler Phases: $ErNi_{1-x}Cu_xSb$, $YNi_{1-x}Cu_xSb$ and $Zr_xHf_yTi_zNiSn$, 18th International Conference on Thermoelectrics, 1999, pgs 344-347; hereinafter "Sportouch") in view of Shen et al. (Synthesis and Sintering of ZrNiSn Thermoelectric Compounds, 21st International Conference on Thermoelectrics, August 25-29, 2002, pgs 166-169, hereinafter "Shen"); Claims 2-4 were rejected under 35 U.S.C. § 103(a) as unpatentable over Sportouch in view of Shen, further in view of Hohl et al. (Efficient dopants for ZrNiSn based thermoelectric materials, J. Phys.: Condens. Matter, 11, 1999, pgs 1697-1709; hereinafter "Hohl"); and Claim 17 was rejected under 35 U.S.C. § 103(a) as unpatentable over Sportouch in view of Shen, further in view of Bell (U.S. Patent No. 6,700,052).

In response to the rejections under 35 U.S.C. §103(a), Applicants respectfully submit that new Claim 25 recites novel features clearly not taught or rendered obvious by the applied references.

Independent Claim 25 is directed to a:

> ...thermoelectric material which is a sintered body and represented by composition formula (1) and comprises as a major phase an MgAgAs crystal structure, the sintered body being obtained by melting raw materials to obtain melted raw

[1] See original Claims 2-4, 17, and 21-24, and Table 1 at page 36 of the specification.

materials, quenching the melted raw materials to obtain an alloy formed of a metallic lump, pulverizing the alloy to obtain an alloy powder, and monolithic molding the alloy powder by sintering, hot press or SPS method, wherein the composition formula (1) is $(Ti_{a1}Zr_{b1}Hf_{c1})_xNi_ySn_{100-x-y}$, and

a1, b1, c1, x and y satisfy the conditions of: $0<a1<1$, ***$0<b1<0.5$***, $0<c1<1$, $a1+b1+c1=1$, $30\leqq x\leqq 35$ and $30\leqq y\leqq 35$,

and the sintered body has a dimensionless figure-of-merit ZT value of not less than 0.05 at 300°K.

By way of background, Applicants' Claim 25 includes the following formula:

$$(Ti_{a1}Zr_{b1}Hf_{c1})_xNi_ySn_{100-x-y},$$

where $0<a1<1$, ***$0<b1<0.5$***, $0<c1<1$, $a1+b1+c1=1$, and $30 \leq x \leq 35$, and $30 \leq y \leq 35$.

Applicants respectfully submit that a thermoelectric material having the above composition is not described in Sportouch. Sportouch, at page 346, left column, shows Table I, reproduced below:

Table I: Thermopower and electrical conductivity at room temperature for the solid solutions $Zr_xHf_yTi_zNiSn$.

Compounds	Thermopower (μV/K)	Electrical Conductivity (S/cm)
$Zr_{0.5}Hf_{0.2}Ti_{0.3}NiSn$	-253	144
$Zr_{0.5}Hf_{0.4}Ti_{0.1}NiSn$	-200	112
$Zr_{0.5}Hf_{0.25}Ti_{0.25}NiSn$	-158	53
$Zr_{0.6}Hf_{0.2}Ti_{0.2}NiSn$	-155	122
$Zr_{0.8}Hf_{0.1}Ti_{0.1}NiSn$	-130	44
$Zr_{0.6}Hf_{0.3}Ti_{0.1}NiSn$	-125	74
$Zr_{0.5}Hf_{0.1}Ti_{0.4}NiSn$	-118	113
$Zr_{0.5}Hf_{0.3}Ti_{0.2}NiSn$	- 25	41

The compositions of the compounds in Table I can be shown by using a1, b1 and c1 as used in the present invention as follows:

Ti a1	Zr b1	Hf c1
0.3	0.5	0.2
0.1	0.5	0.4
0.25	0.5	0.25
0.2	0.6	0.2
0.1	0.8	0.1
0.1	0.6	0.3
0.4	0.5	0.1
0.2	0.5	0.3

Regarding the compounds of Sportouch, $ZT=\alpha^2/(\rho\kappa)$ at 300K is calculated, "α" represents the thermopower shown in Table I, while the unit is changed to "V/K." "ρ" represents the electrical resistivity which is indicated by the inverse number of electrical conductivity. The electrical conductivity is shown in Table I. For example, the electrical conductivity of the first compound "$Ti_{0.3}Zr_{0.5}Hf_{0.2}NiSn$" in Table I is 144(S/cm) = 144($\Omega^{-1}cm^{-1}$). Accordingly, the electrical resistivity ρ is 1/144[Ωcm] = 6.94×10^{-3}(Ωcm) =6.94×10^{-5}(Ωm).

The values indicated in Sportouch are used as the thermal conductivities κ. However, Sportouch only indicates the thermal conductivities κ for the following compounds (see page 346, right column, 2nd paragraph):

The first compounds: ($Ti_{0.3}Zr_{0.5}Hf_{0.2}NiSn$): 57[mW/cmK] = 5.7[W/mK]

The third compounds: ($Ti_{0.25}Zr_{0.5}Hf_{0.25}NiSn$): 65[mW/cmK] = 6.5[W/mK]

The seventh compounds: ($Ti_{0.4}Zr_{0.5}Hf_{0.1}NiSn$): 61[mW/cmK] = 6.1[W/mK]

For the other compounds, the smallest value, i.e., 5.7(W/mK) is used.

Please refer to Table A for the calculated ZT (at 300 K), thermopower α, electrical resistivity ρ and thermal conductivity κ below.

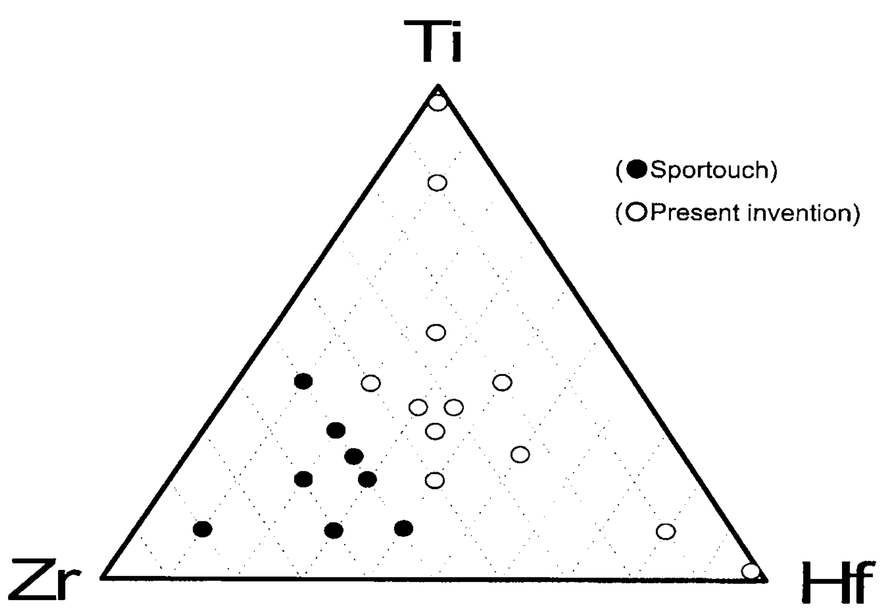
Table A

Ti a1	Zr b1	Hf c1	α[V/K]	ρ[Ωm]	κ[W/mK]	ZT(300K)
0.3	**0.5**	**0.2**	**-2.53×10^{-4}**	**6.94×10^{-5}**	**5.7**	**0.049**
0.1	0.5	0.4	-2.00×10^{-4}	8.93×10^{-5}	5.7	0.024
0.25	0.5	0.25	-1.58×10^{-4}	1.89×10^{-4}	6.5	0.006
0.2	0.6	0.2	-1.55×10^{-4}	8.20×10^{-5}	5.7	0.015
0.1	0.8	0.1	-1.30×10^{-4}	2.27×10^{-4}	5.7	0.004
0.1	0.6	0.3	-1.25×10^{-4}	1.35×10^{-4}	5.7	0.006
0.4	0.5	0.1	-1.18×10^{-4}	8.85×10^{-5}	6.1	0.008
0.2	0.5	0.3	-2.50×10^{-5}	2.44×10^{-4}	5.7	0.0001

As shown in Table A, if the compounds of Sportouch are represented by $(Ti_{a1}Zr_{b1}Hf_{c1})_xNi_ySn_{100-x-y}$, b1 is ***0.5 or more***. On the other hand, in the present invention, b1 should satisfy **0<b1<0.5** in $(Ti_{a1}Zr_{b1}Hf_{c1})_xNi_ySn_{100-x-y}$.

That is, the composition of Applicants' thermoelectric material is clearly different from that of compounds described in Sportouch. The differences between the Applicants' thermoelectric material and the material of Sportouch is shown in the composition diagram below.

In the diagram reproduced below, ○ indicates compositions of compounds used as examples of the thermoelectric material of the present invention, and ● indicates compositions of compounds used in Sportouch. Sportouch does not teach or suggest that b1 in $(Ti_{a1}Zr_{b1}Hf_{c1})_xNi_ySn_{100-x-y}$ is set to be less than 0.5. Further, Sportouch does not have a need or motivation to use such a b1 value.



In addition, as shown in Table A, the maximum value of ZT (at 300K) in Sportouch is 0.049. This value corresponds to the smallest value of ZT (at 300K) for the thermoelectric

material of the Applicants' invention. Next, Applicants refer to a partial extract of Table 1 shown at page 36 of the specification.

Table 1

		a_1	b_1	c_1	ZT(300K)
Examples	I-1	0.3	0.35	0.35	0.12
	I-2	0.01	0.01	0.98	0.06
	I-4	**0.98**	**0.01**	**0.01**	**0.05**
	I-5	0.02	0.49	0.49	0.07
	I-6	0.49	0.02	0.49	0.07
	I-7	0.49	0.49	0.02	0.06
	I-8	0.1	0.1	0.8	0.08
	I-10	0.8	0.1	0.1	0.09
	I-11	0.35	0.3	0.35	0.13
	I-12	0.35	0.35	0.3	0.12
	I-13	0.1	0.45	0.45	0.08
	I-14	0.45	0.1	0.45	0.07
	I-15	0.45	0.45	0.1	0.07
	I-16	0.2	0.4	0.4	0.10
	I-17	0.4	0.2	0.4	0.09
	I-18	0.4	0.4	0.2	0.10
	I-19	0.5	0.25	0.25	0.12
	I-21	0.25	0.25	0.5	0.11

As can be seen from the above table, the ZT (at 300K) of the thermoelectric material of the present invention is clearly greater than that of Sportouch, thus the Applicants' thermoelectric material has superior qualities.

As stated above, the thermoelectric material of the Applicants' invention has a unique composition, and is a sintered body which is obtained by a specific method. Applicants'

thermoelectric material which satisfies these conditions is excellent in performance. However, Sportouch does not satisfy these conditions.

Further, Applicants respectfully submit that Shen fails to cure any of the above-noted deficiencies of Sportouch. Thus, Applicants respectfully submit that independent Claim 25 (and all claims depending thereon) patentably distinguishes over Sportouch in view of Shen.

Accordingly, Applicants respectfully request that the rejections under 35 U.S.C. §103(a) be withdrawn.

Consequently, in view of the present amendment, and in light of the above discussion, the pending claims as presented herewith are believed to be in condition for formal allowance, and an early and favorable action to that effect is respectfully requested.

Respectfully submitted,

OBLON, SPIVAK, McCLELLAND,
MAIER & NEUSTADT, L.L.P.

Derek P. Benke

Eckhard H. Kuesters
Attorney of Record
Registration No. 28,870

Derek P. Benke
Registration No. 56,944

Customer Number
22850

Tel: (703) 413-3000
Fax: (703) 413 -2220
(OSMMN 08/09)